McMATH-HULBERT OBSERVATORY OF THE UNIVERSITY OF MICHIGAN

(Report from Solar Institute)

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The McMath-Hulbert Observatory ($5^h33^m03^sW$, $42°39'48''N$) is the solar research center of the Department of Astronomy of The University of Michigan. It is located on the North shore of Lake Angelus, 5 miles from the center of Pontiac, Mich., and 55 miles from Ann Arbor, the principal campus of the University.

1. History

The McMath-Hulbert Observatory was founded in 1930 by Judge Henry S. Hulbert, Mr. Francis C. McMath, and his son Dr. Robert R. McMath. The latter was Director of the observatory from its founding until his death in 1962. The observatory began as a private project devoted to the development of new methods of observing celestial objects, especially by motion-picture techniques and time-lapse photography. In 1931 the observatory was deeded by its founders to the University of Michigan.

In 1931 and 1932, the original $10\frac{1}{2}$-inch reflecting telescope secured pioneering cinematographic records of the motions of the satellites of Jupiter, of the rotation of the planets, and of sunrise and sunset on the mountains of the moon.

These lunar and planetary observations were preliminary to the expansion of the observatory that began in 1932 with the design and construction of the 'Spectroheliokinematograph' for use with the $10\frac{1}{2}$-inch reflector in the study of the sun. With this instrument motions of solar prominences were first recorded by time-lapse photography, and then studied by viewing the motion pictures many times.

Until 1958, financial support for instrumentation was provided entirely through gifts from private donors and grants from the Rackham and McGregor Funds of Detroit. The first major solar instruments, the 50-foot solar tower and spectroheliograph, were built in 1936 (Figures 1 and 2). In 1940 the McGregor Solar Tower was constructed and in 1955 the vacuum spectrograph was put into operation (Figure 3).

As part of the International Geophysical Year (1958), the Observatory was given one of the first of the Hα flare-patrol telescopes (Figure 4). In 1967 the ground-based equipment was augmented by an instrument designed to record solar X-radiation and mounted in the satellite OSO-III. All mirrors in the optical trains of the solar telescopes at the McMath-Hulbert Observatory have been changed from Pyrex to Cer-Vit, a ceramic, vitreous material with practically zero coefficient of expansion. An instrument shop, offices, and a library complete the solar observatory at Lake Angelus.

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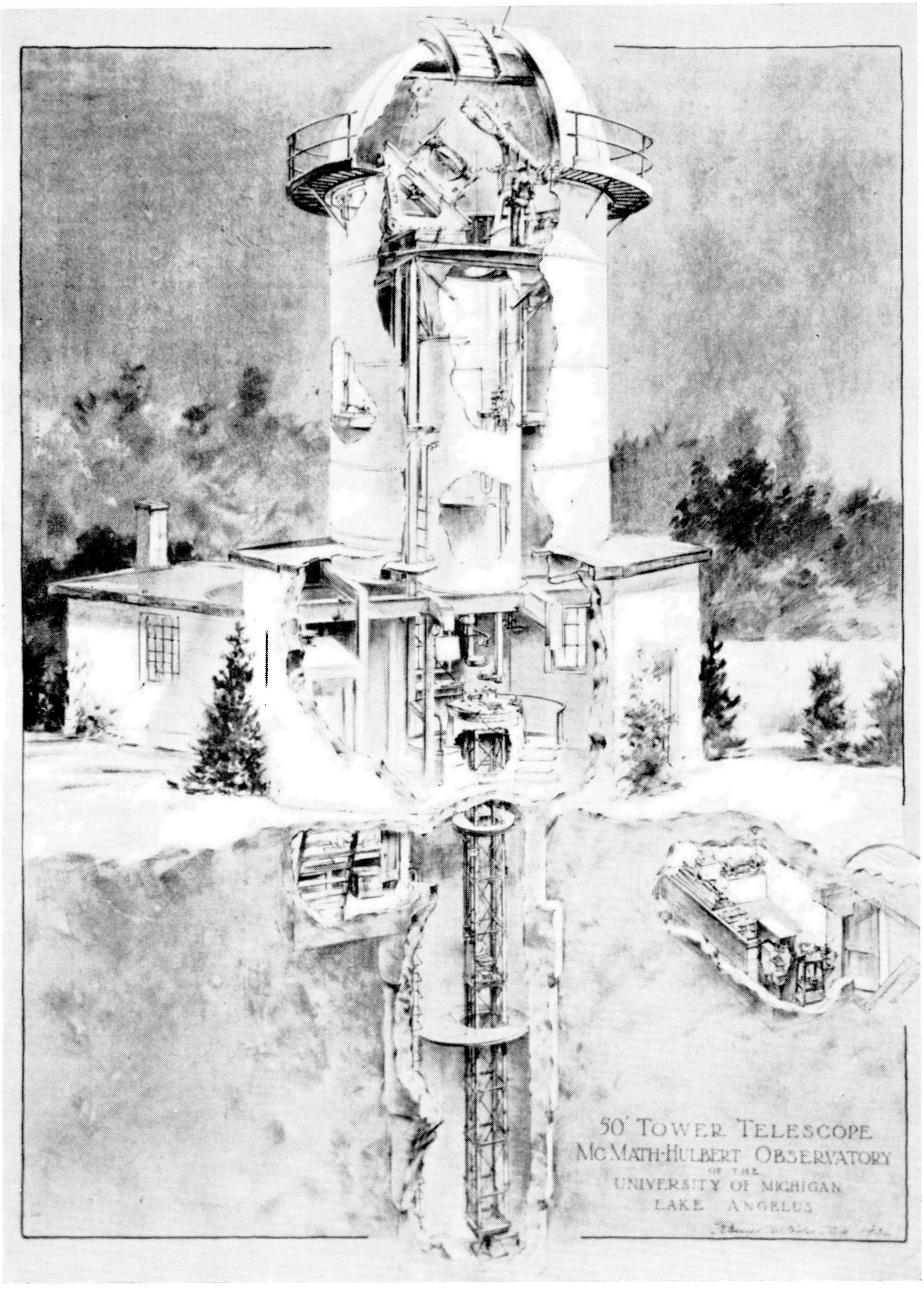

Fig. 1. The 50-foot tower telescope of the McMath-Hulbert Observatory, from a drawing by Russell W. Porter.

2. Instruments

1. *50-foot solar tower and spectroheliograph.* – The solar telescope consists of two independent, mutually isolated steel towers approximately 50 feet high. The outer tower, $16\frac{1}{2}$ feet in diameter, serves both as a windbreak and sunshade for the inner tower, which is 6 feet in diameter. All optical parts are supported by the inner tower. A coelostat mirror 22 inches in diameter provides a solar beam for any one of three image-forming systems:

(1) 16-inch, off-axis parabolic mirror, 40-feet focal length;
(2) 12-inch, off-axis parabolic mirror, 20-feet focal length;
(3) $3\frac{1}{2}$-inch, Ross type lens, 74 inches focal length.

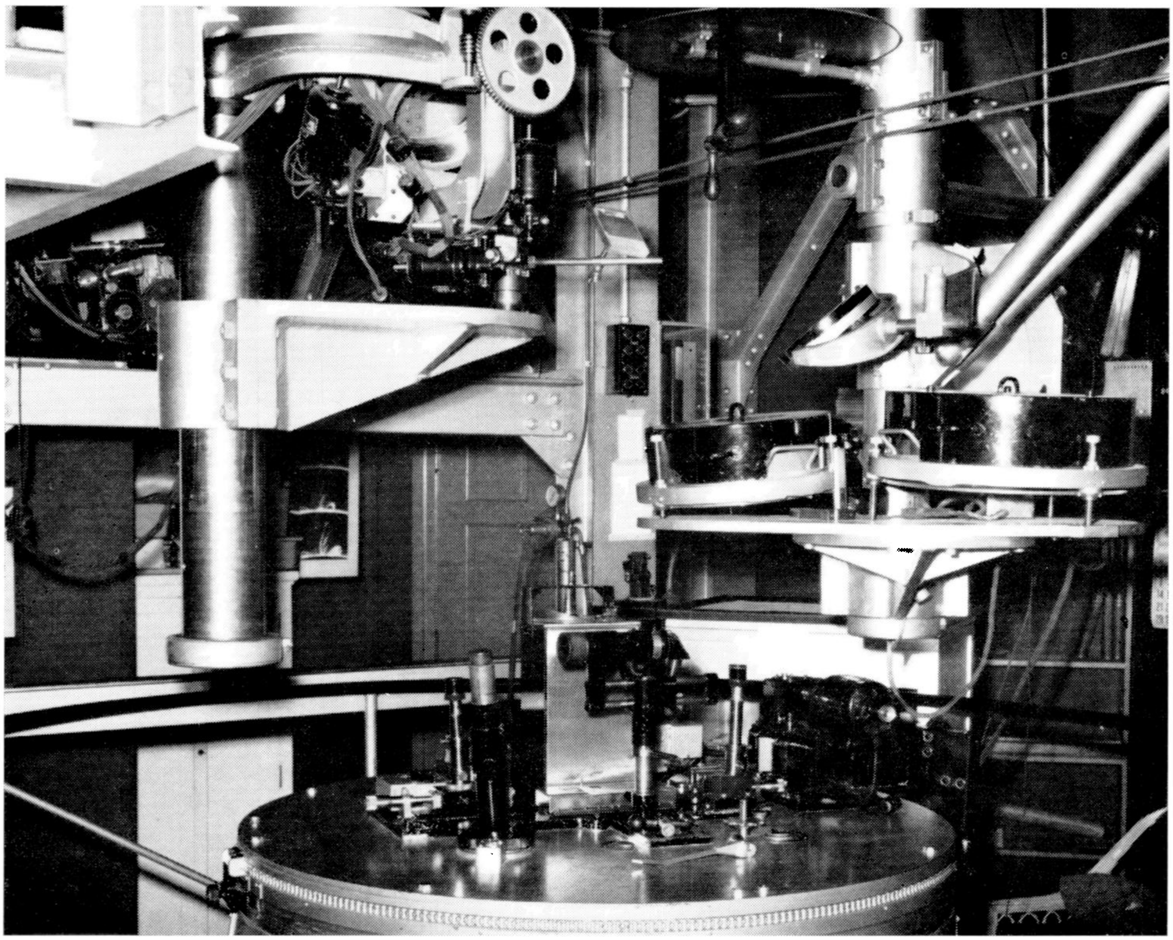

Fig. 2. Observing room of the 50-foot tower telescope, McMath-Hulbert Observatory.

Auxiliary mirrors and lenses also permit focal lengths of 50 feet and 8 feet.

The spectrograph with focal lengths of 15 and 30 feet is fitted with a Babcock grating blazed in the first-order-red.

2. *McGregor solar tower and vacuum spectrograph.* – Double steel towers similar in construction to those of the 50-foot solar tower, but approximately 70 feet high,

constitute the supporting structure of the McGregor solar tower telescope. Off-axis parabolic mirrors with focal lengths ranging from 50 to 100 feet provide solar images for the vacuum spectrograph. A Babcock grating blazed in the fifth-order-green, is the dispersive element of the spectrograph. For the fifth order Hα the dispersion is 28.3 mm/Å and for eighth order K, 23.2 mm/Å. The spectrograph can be used either photographically or as a direct intensity spectrometer. For the latter mode, a digital output has been introduced.

3. *X-ray recorder – Satellite, OSO-III.* – An instrument designed to detect the soft X-ray component of solar radiation is in flight on OSO-III and has supplied data for at least a year starting March 9, 1967.

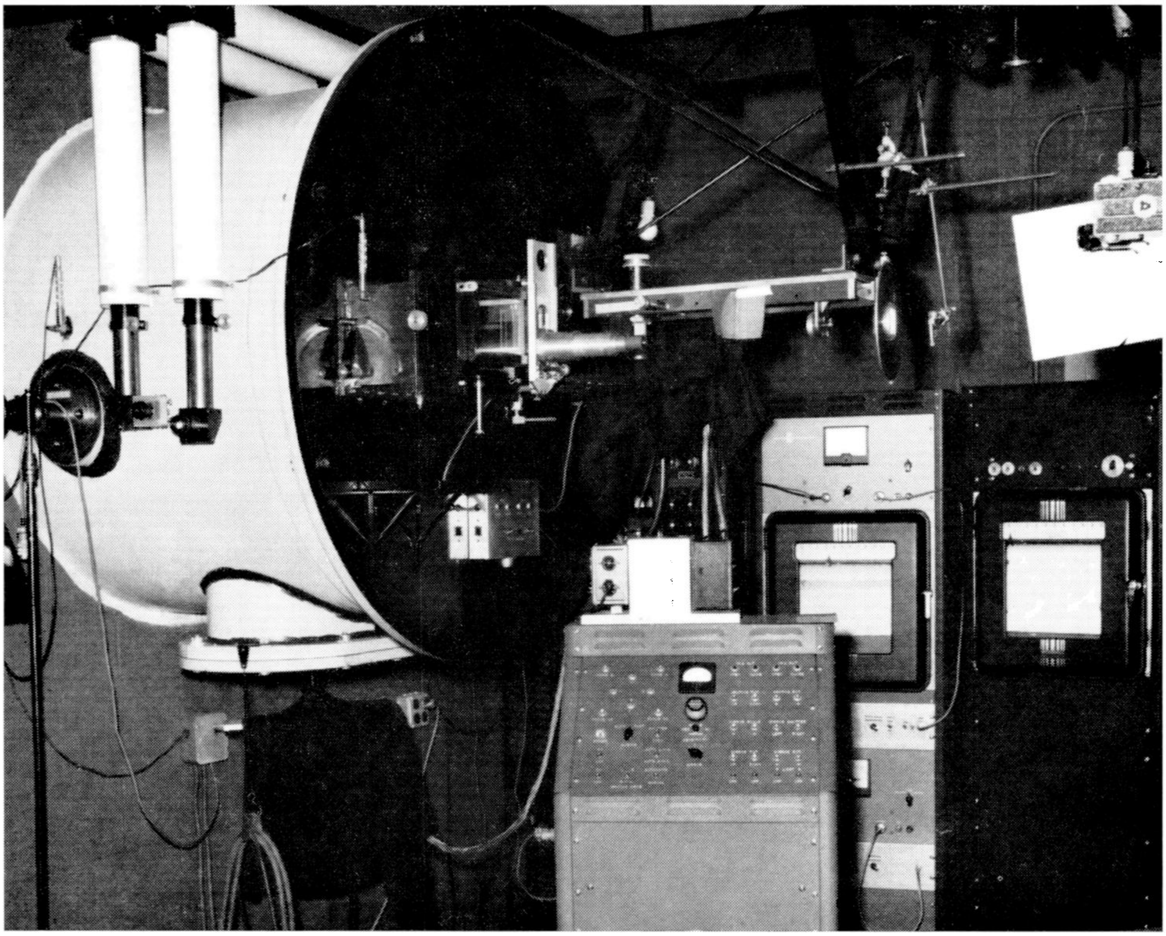

Fig. 3. The observing room of the McGregor vacuum spectrograph, McMath-Hulbert Observatory.

4. *Monochromatic heliograph.* – This instrument (used in the international flare-patrol) is a refracting telescope with objective 14 cm in diameter. It is designed for automatic photographic observation of the solar disk in Hα radiation. The monochromatic filter is of the type developed by Lyot and has a band pass of 0.5 Å.

5. *Microdensitometer.* – The versatile microdensitometer was built in the Observatory

shop for the study of observations photographically recorded. The microdensitometer provides variable intermittent, or continuous motions in two orthogonal directions. These motions facilitate the representation of photographic densities in graphical forms such as lines of constant intensity, and many other procedures developed to make full use of solar direct and spectrum photography.

6. *Geophysical laboratory.* – Transient variations in 10 MHz and 15 MHz signals from WWV (Colorado) provide information on certain ionospheric effects of solar flares.

18 MHz riometer records indicate both solar radiation at this frequency and ionospheric absorption of the 18 MHz radiation from the Milky Way at the time of certain solar flares. Auroral absorption is also registered.

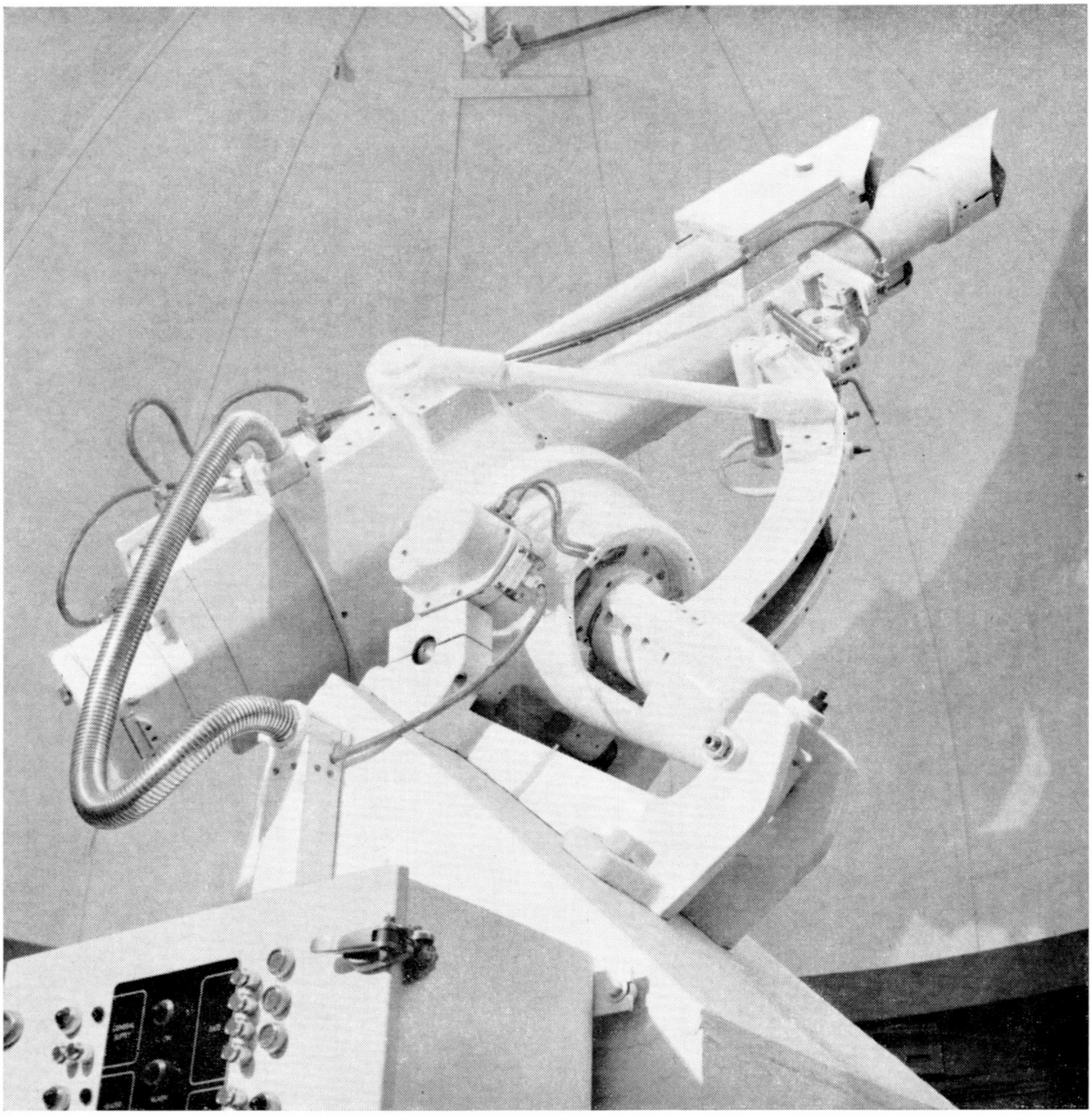

Fig. 4. Monochromatic heliograph and flare-patrol telescope, McMath-Hulbert Observatory.

A flux-gate magnetometer gives the X, Y, and Z components of the earth's magnetic field and indicates the occurrence of geomagnetic storms.

3. Research Programs

Analyses based on high-dispersion spectra are directed towards improved models of the solar atmosphere, more accurate determination of solar abundances, and a better understanding of the physical nature of centers of activity.

Magnetohydrodynamical studies concerned with solar rotation, the solar magnetic field, and centers of activity are in progress.

Records of solar plages, flares, and sunspots are used to follow the course of solar activity from day to day, and to investigate the general development of the entire solar cycle. Special flares and centers of activity are studied in detail. Problems in solar-terrestrial relationships are considered.

Variations of the soft X-radiation (8–12 Å) from the sun are compared to transient and slowly varying phenomena observed at other wavelengths.

4. Publications

Research manuscripts and data reports are published in appropriate professional journals. The Observatory does not maintain a special publication series.